Original Article

WEARABLE ROBOTIC DEVICE DESIGNED TO IMPROVE MUSCULAR STRENGTH IN CEREBRALPALSY

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Abstract

Cerebral palsy has traditionally been thought of as a mobility and gait issue caused by a non-progressive damage to the developing mind. While indicative usual symptoms may occur at an earlier age, the characteristics of this entity develop over time, and the particular cerebral palsy condition may not be recognized until the child is between the ages of 3 and 5. Crouch walk, and severe knee bending when moving, is one of the most prevalent indicators of cerebral palsy. Leg splints, muscle damage, physical therapy, and leg surgeries can all assist children with cerebral palsy enhance their walking skills. Current gait trainers are primarily concerned with managing full joint trajectories, avoiding postural control, and tailoring therapy to a specific patient. Robotic exoskeletons used for adult with total paralysis, this one did not walk for the participant. They used their muscle to walk and assisted robot. The hope is that the device which is use will strengthen a child's muscle to improve unassisted walking. The use of the CP Walker, a revolutionary mechanical system for children with spastic palsy.

INTRODUCTION

Robotics is the combination of science, technology, and computing that result in devices called robots which replace human actions. Electronic equipment are required for robots to manage and operate the machines. The ankle joint flexor muscles are a crucial component of a smooth walk, responsible for almost half of the propelling forces generated during moving. (1). Muscle paresis, along with muscle stiffness, decreased selective. One of the most significant motor deficits in teenagers and young adults with cerebral palsy is increased co-activation (CP). There is a shortage of information on the impact of muscular strength on gait in CP teenagers and young adults. Isometric muscular strength in CP can be measured with moderate to high reliability with a use of Hand-Held dynamometry(2).Isometric power of the lower limb is much lower in children with spastic CP than in their normally developing peers(2). The quantity of kids with spastic cerebral palsy (CP), a neurodegenerative illness due to brain injury that occurs before complete cerebral maturation, have spastic cerebral palsy, have reduced ankle plantar flexor muscle function, which is likely a significant component in walking issues(1). Long-term unloading may cause muscle atrophy and reductions in plantar flexor neuromotor function. Effective gait therapy methods should offer ankle plantar flexor resistance that is precisely timed while moving to generate the ideal neuromuscular firing pattern that reinforces proper function, resulting in increased power, balance, and gait (2). A spastic muscle or a collection of spastic muscles can be able to overcome antagonists who are spastic, regular, or floppy in nature. Soft-tissue and skeletal alterations may result as a result of this. The ankle joint is the most visible sign of lower-limb dysfunction(3).

The study's primary aim is to create and test a direct method for an exoskeleton that can be worn that might provide When moving, patients with spastic CP need adapted barrier proportionate to the physiological foot motion. The study's secondary purpose was to see if for persons with spastic CP, moving with plantar flexor opposition was possible, as was evaluating the neurological reaction to resistant moving for early clinical confirmation of this therapeutically training approach. Walking with resistance increases plantar flexor muscle activity in the stance phase of the afflicted limb(1).

PATHOPHYSIOLOGY

Cerebral palsy is a collection of non - forward thinking postural and motor impairment disorders that limit activities and are frequently accompanied by other neurological problems such as particular cognitive or optical abnormalities(4). The abnormality (damage) to the developing brain can happen in gestation, after childbirth, in the post-neonatal era, or further in early infancy. Hypoxia, infection, stroke, or hypotension are frequent cause of damage, with an inflammatory cascade following the initial insult(5). Around 10% of cerebral palsy is develops by post-neonatal reasons such as illness, hypoglycemia, haemorrhage, and both accidental and non-accidental trauma. Around 80% of cerebral palsy is develops by a brain damage that happens in the womb(5).Cellular growth activities, as well as stability processes and circuitry specialisation, are most prevalent in the second trimester of pregnancy and last after birth, with the first two years of life being the most intense. At this stage of brain development, environmental variables such as hypoxia, ischemia play a role in the formation of CP. As a result, CP is caused by both destructive and developmental pathways(4). Muscles with spastic CP frequently develop spasticity, which reduce joint mobility and make muscles seem functionally short(6).

Causes and risk factors of cerebral palsy

- Associated birth defects
- Head trauma
- Maternal infection
- Intracranial haemorrhage, white matter injury.
- Meningitis
- Hypoxia(7)

Exoskeletal framework for wearable resistance

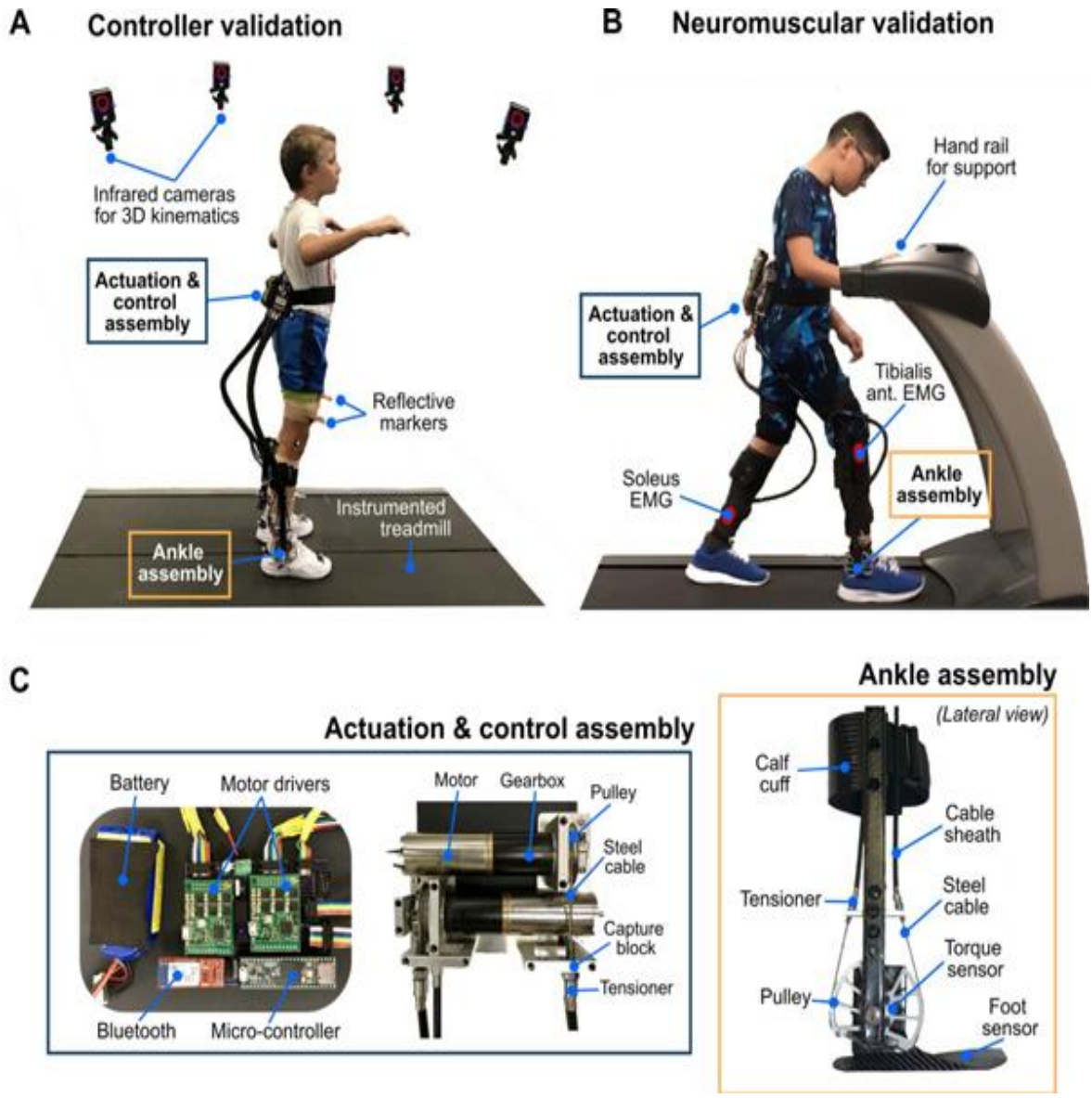

Figure1. This above setup is of control and neuromuscular validation which is used for experimental purpose. A) In this experiment we take a person a name shraddha. Shraddha wore a bespoke exoskeleton and reflective markers in above experiment while walking with resistance on an instrumental treadmill to acquire 3D kinematics and kinetics. B) Shraddha provided with a bespoke ankle exoskeleton as well as bilateral soleus and tibialis anterior. C) The participant shraddha wore an ankle exoskeletal(8).

Procedure for robotic devices

The procedure for above experimental setup is that shraddha was given a wearable plantar flexor resistance which is previously developed ankle resistance designed to improve ankle strength which is useful in cerebral palsy. The materials used in this experiment are lightweight ankle exoskeleton has individually adjustable foot implants and calf cuffs for a customised fit, A higher Voltage motor driven by an onboard battery actuates a pulley is attached to each foot joint in the sagittal plane by a Bowden cable, generates bilateral ankle force. The torque and power controller receives data from torque sensor at the ankle joint. A unique printed electronic circuit, wireless connectivity, a microprocessor, signal analysers and motion control are all part of the exoskeleton's control module. A finite state system and a resistant control algorithm are implemented on the microcontroller, and experimental results is sent to the GUI. On the basis of two key design goals, created a custom exoskeleton resistance controller. The first requirement for experiment was task-specificity: the controller had to allow for enhanced neurological firing of the plantar flexion muscles during the phase of the gait cycle when they are used to move the body ahead.

The second requirement was user engagement: the controller should be sensitive to changing user input and deliver a physical indication in response. To achieve these objectives in this experiment, developed a proportionate joint-moment control method that provides adaptable resistance for Embedded foot detectors implanted beneath the physiological heel motion was measured using the heel of the ankle in actual(8).

TYPES OF ROBOTICS DEVICES

1.The NF-Walker (Fig 1) is a robotic device that assists persons suffering from cerebral palsy. a mixed supportive component that provides active assistance for upright posture as well as movement The gadget wheels release the patient's load. This gadget offers users with motor stimulus and a sensation of success. It may be adjusted to the patient, who has been maintained in a straight and proper attitude including both arms open. This gadget has the capability to enhance movement growth in children who have cerebral mobility disability.(9)

2. The Lokomat (Fig 2) seems to be the most frequently utilized medical physiotherapy robotic platform in the world. It is a robotic system for the therapy of robotic aided physical therapy in people of all ages.This gadget has 2 leg exoskeleton including motor actuators, a body mass hold up, and a synchronised treadmill. Lokomat enables doctors to concentrate on the subject and the therapy itself. It improves staff efficacy and safety, leading to increased exercise training, more sessions per therapists, and constant better subject care.(9)

3.Gait Trainer GT-1 Rehastim (Fig 3) aim to increase the subject capacity to move via challenging activities The subject weight is alleviated, and youngsters are placed on 2 footplates that imitate the stance and swing stages of walking. Subject are placed in a cage and placed on 2 footplates, which motions imitate the stance and swing stages, with a 60 percent to 40 rate conecting the two components.(9)

Fig 1. NF- Walker

Fig 2. Lokomat

Fig 3. Gait Trainer GT-1

REVIEW ARTICLE

• The Northern Arizona University Institutional Review Board approved this study, in which this study enrolled eight people having spastic CP in order to confirm the manage technique and experimentally investigate the neurological response to active resistance therapy while moving. There was two target Controller validation (Target 1) and the practicality as well as neurological reaction procedure (Target 2), We accomplished our initial aim by demonstrating that the adaptable resistant controller applied force proportionate to the biological foot movement while walking. Results of this experiment shows that walking rehabilitation which involving plantar flexor force given by exoskeleton was acceptable by people with spastic cerebral palsy.(8-25)

• Martinez Hernandez et al. 2020 approved this study in which there was healthy participants. The participants having problem with dorsiflexion movement. The gadget which is used in this experiment was comprised of smooth and firm substances and contains a single inertial detector. The ankle robotic machine recognises moving actions and gait phases using a large technique to command the wearable gadget to function in assistance and transparency ways. Toe-off sensor activates an assistance way and in a transparency way, which is enabled via heel contact sensor. Result from this experiment shows that the wearable robot's capacity to work based on the gait phase detected while moving.(10)

• Smania et al has an experiment on 11year old child who was unable to move without support owing to ataxic quadriparesis was tested using NF Walker device.2-minute walking test, the 10-meter walking test, respiratory and cardiac measurements, and the energy cost of locomotion were all performed on the subject. The result from this experiment shows that the NF-Walker can help individuals with CP who have significant mobility disability to roam around in their surroundings as a result of cp.(26-36)

Rehabilitation

Physiotherapy must have specific goals, like as increasing involvement or avoiding muscle twitching issues including discomfort and joint contractures. Therapists educate families how and where to hold and place there infant for feeding at house, cleaning, dressing as well as other daily duties. Children experiencing muscular pain and restricted joint movement should see a clinician. Three evaluations using a structured approach Resistance training physiotherapy programmes have been shown to enhance power, mobility, and involvement without causing negative side effects. Parents must be aware that formal physiotherapy has a significant but minimum role in the overall care of afflicted individuals, and that all programmes need participation from both school and home.(37-)

SUMMARY

A strength of the robot system used in this study is dislocation in a practical setting whereas the equipment provides guidance in terms of enhancing young children's posture. During the walking transition task, the proportional combined regulator calculated the stance-phase physiological foot movement in actual time, which changed dramatically, up to 77% of the optimum. As estimated ankle moment matched the time, shape, and amplitude of the required torque profile defined by the proportional joint-moment control. While treadmill training at their continuous desired pace with proportional joint-moment control, participants percent decreases in transfer metabolic expenditure, accordingly, when compared to walking without assistance. Most of the time, the source is unclear, and preterm is the most common risk factor. Finally, this research found the efficacy and applicability of an innovative training strategy and process for enhancing plantar flexion activation when moving inside the practical contextual range of patients with spastic cp.

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